AGRICULTURAL INDUSTRIES IN INDIA.

BY

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WITH AN INTRODUCTION

BY

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MADRAS

INTRODUCTION.

Although myself not an agriculturist, I fully realise that the whole industrial economy of India must ultimately rest on a highly developed system of agriculture and I have, therefore, much pleasure in writing these few lines by way of introduction to the essays comprising this little book. Mr. S. R. Sayani, I think, has given valuable information regarding the present state and future possibilities of the principal cultivated crops of India. The ryot is sometimes ignorantly blamed for not adopting modern methods. But experience has shown that, generally speaking, he is not unwilling to change his traditional methods in favour of new ones of proved efficacy. It is not his fault if he does not use a plough which is too heavy for the bullocks in his part of the country, or delicate machinery which cannot be cheaply repaired by the village carpenter. Individually, too, he has not enough capital to invest in costly machines.

In this connection, I may take this opportunity of expressing my strong belief in the value of the co-operative movement, represented by the Co-operative Credit Societies that have been started in different parts of the country. Carefully worked, I think it will help the ryot to solve many of the problems of agriculture and at the same time to lay the foundations of a character for public spirit and self-reliance. I would commend to the perusal of the readers of this little book, Mr. Pratt's valuable work entitled "The Organization of Agriculture," which gives an inspiring account of what great things have been done for agriculture in European countries by means of the co-operative principle.

BOMBAY,
28th September, 1909. } V. D. THACKERSEY.

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Agricultural Industries in India.

AGRICULTURAL PROBLEM IN INDIA.

AGRICULTURE or tillage is the oldest science as well as art on the earth. Still even in advanced countries it has not reached a state of perfection. But in many countries for instance India, it is still, generally speaking, in a primitive state. The reason is not far to seek. For ordinary purposes a superficial knowledge of certain natural laws and an empiric knowledge of sowing, harvesting, etc., proves sufficient. The rest is done by natural forces such as water, sunshine, and air. However, the object of a farmer is, at any rate should be, not simply the growing of crops but the production of the best results for the money, time and trouble expended by him on his field. The first thing a farmer has to consider is, what he should grow. In order to come to a proper decision even on this single point he must know the different products his land is capable of producing. Of these he will

have to reject several, simply on the principle known as the 'rotation of crops.' This done, he will proceed to consider which crops will be most paying to him considering the limited amount of money and skill at his command, which manures he will be able to use and for what kind of crops they are most suitable. Even the selection of seeds will tax his utmost skill. For on them will depend largely the quality of the crop. The implements used and the methods of sowing will also exert an important influence. Before the crop can be marketed advantageously he will have to overcome many other difficulties. Now the question arises, can he do all these things without any scientific knowledge of agriculture? Although it is true that all this can be done fairly well with the help of experience derived in actual farming, a knowledge of scientific farming will doubtless assist a farmer. In the first place, it will supply to a certain extent the place of experience. It will often do away with the necessity of wasting his time on costly as well as fruitless experiments. It will thus

make farming more paying and a pleasurable occupation.

We have shown above the beneficial uses of a scientific knowledge of the principles of agriculture. In these days it is almost a necessity. Agricultural products are now largely exported and a world-wide competition has cut down the level of profits. Hence any deterioration of quality or lowering of the average output often destroys agricultural industries by making them profitless. As an example of this may be quoted the case of the sugar-making industry. Although India has got many natural advantages for the development of this industry the imports of cheap foreign sugar are increasing every year. This is simply due to the fact that the Indian agriculturist is ignorant of scientific methods, which affects his work in many ways. In the first place, his want of knowledge tends to make sugar cane growing a commercial failure, because he either overdoes manuring or does not apply it sufficiently. Even if he succeeds in growing the cane satisfactorily, the sugar

made from it is not sufficient because, the juice extracted by his primitive machines is defective both in quality and sweetness. The former is due to his antiquated machines, and the latter to unsuitable methods of cultivation. Thus at every step, his ignorance of even the elementary principles of scientific agriculture, proves a stumbling block. This is only one example out of many, but is sufficient to prove that scientific principles may beneficially be applied to the antiquated agricultural systems of India. We shall, therefore, now proceed to indicate generally in what directions improvements are possible.

In the case of farming as well as in any other business it is true that 'no school is better than the school of practical experience.' Nevertheless, a scientific training will assist an agriculturist in the following :—

(1) The selection of land for the crop he wishes to grow; in the contrary case, the selection of crop for the land he holds. An application of scientific principles aided with practical experience, will often enable a farmer

to produce paying crops from waste or unprofitable lands. For instance, one piece of land may be able to grow cotton in abundance, but not sugar cane; or it may produce sugar cane of one particular variety and still be unsuitable for another variety.

(2) Selection of seeds is also a portion of the farmer's work requiring much skill and expert knowledge. Want of knowledge in this may nullify to a considerable extent the time and trouble spent on the crops.

(3) The methods of cultivation and the implements used are also in their own way very important. This is particularly the case in this country where the antiquated methods are capable of much improvement without increasing greatly the cost of cultivation.

(4) Economy of water; that is, with the aid of scientific methods to make the same quantity of water irrigate a larger area than before. In America some success has been achieved in retaining rain water in the soil, so as to make irrigation less necessary, if not unnecessary. If any success is obtained in

India in this direction it will decrease the area affected by the periodical droughts.

(5) Improvement of seeds; the great possibilities of agricultural improvements in this line are exemplified by the successful introduction of the superior variety of cotton, known as Egyptian cotton. If its cultivation can be widely extended it will revolutionise the trade conditions of India.

(6) Introduction of new crops. For instance, jute was practically unknown in India about a hundred years back. Now its output nearly amounts to forty-five crores of rupees annually.

(7) Suitable rotation of crops. For instance, it was recently found by Mr. Smith, the Deputy Director of Agriculture, Bengal, that jute and paddy could be grown on the same piece of land in one year, one after the other. If practical use can be made of this discovery it will put into the pocket of the cultivators a sum running into crores of rupees. It will also tend to keep down the prices of food stuffs so far as they are adversely affected

by the substitution of other crops in the place of food crops.

(8) Use of suitable manures. Want of suitable manures tends to make the land less productive and the average production comparatively less than in other countries. Hence the use of good artificial manures will not only keep up the productiveness of the land but will make agricultural industries more profitable.

(9) Improvement and management of the cattle. Since agriculture depends largely on animal agency in this country, the importance of this line is apparent. Moreover, milk and its products form the staple food of a large number of Indians.

(10) The gradual conversion of the export trade in raw products, into manufactures, or partly manufactured articles. Even one single instance will suffice to show the enormous scope of improvement in this respect. India exports oilseeds worth nearly 15 crores of rupees every year. Instead of this if they are exported in the form of oil we shall reap a threefold advantage :—

(*a*) An enormous saving in freight.

(*b*) Employment of a large number of people in the industries connected with it.

(*c*) The oil cakes which will remain in the country, by enriching the land, will make it more productive. If they are exported, they and the oils will together bring in a much larger sum than that obtained before for the oilseeds.

Questions, involving the agricultural problem in India are now becoming somewhat complex through the introduction of many new and unforeseen circumstances. Fifty years back, no one would have seriously considered such a contingency for India as a scarcity of labour; cheap and abundant labour was a factor which most people counted upon as certain. Yet want of sufficient labour has already begun to be felt in many trade centres in India. It is a growing problem for all who have the

industrial progress of India at heart, and if neglected it is sure to develop gradually into a stumbling block to our industrial progress.

The question therefore naturally arises, what are the methods by which this unexpected difficulty can be overcome, or at any rate lessened? Were India a sparsely inhabited country, with large vacant areas of arable land, the best remedy perhaps would have been to encourage immigration and the importing of cheap foreign labour. But the case of India is almost exactly the reverse. The difficulty lies, not in the scarcity of labour, in its literal sense, but in the employment of too many men on works which could well be performed by a much smaller number. The reason of this is not difficult to see. Agriculture, as we all know, is the employment of about eighty or eighty-five per cent. of Indians. Owing to many combined causes, this industry is carried on with very primitive methods. The result is that a considerable portion of the labouring population, which could profitably be employed in other produc-

tive industries, are now unnecessarily locked up in the agricultural industries. This being the root of the whole difficulty we must try to find out the cause of this state of things, as also their probable remedies, if any.

If we compare the quantity of work done by a given number of people in advanced countries with the same amount done in India, the contrast is very striking. In the United States, for instance, five workmen can perform as much agricultural work with improved machinery as would require one hundred labourers in India working with their antiquated implements. The chief reasons why agricultural machinery is not used in India are three :—

(1) The ignorance of the ryot,

(2) His poverty, and

(3) The fact that in India the chief agricultural industries of food products, oilseeds, cotton seeds, etc., are in the hands of the poor classes.

The first cause is combined with the other causes in such a way that it cannot be removed

entirely until the other causes are also removed. The remedy partly lies in free primary education followed and to a certain extent, accompanied by technical education. But the education of a nation is not a question of days or years but of generations. The chief obstacle in the way of education is financial. Any scheme of free primary education would cost perhaps one or two crores of rupees annually. This obstacle, however, may perhaps be overcome by introducing free and compulsory education in the larger towns only in the beginning, and by making education a function of the Municipal authorities. In order to enable the Municipalities to undertake this extra expense, one or two new sources of revenue may be made over to them. The task of educating the masses is, as we have already said, a question of many a long year. But much useful work in that direction can be undertaken at once. It will take generations perhaps before an average cultivator will take kindly to highly improved agricultural machinery, even if he can afford it. However, Indian agriculturists do not possess

in the majority of cases even improved implements of the same kind that they are using at present. The reason is, that at present there is no agency which can familiarise them with such improved implements. As India is a country producing agricultural products on a large scale, and at the same time the output per acre is small, even slight improvements will certainly give appreciable results. Therefore, the time and trouble expended on getting even better implements for the agriculturists, will not have been wasted. This may be accomplished to a certain extent by holding large Agricultural Exhibitions at important centres, followed by Branch Exhibitions in many other places. Co-operative Societies should also be formed whose chief work should be to supply cheap agricultural stores to the cultivators. As powerful Joint-Stock Companies, dealing direct with the manufacturers can obtain the best terms, they will no doubt be able to supply the ryot with improved implements and at the same time earn a moderate profit for themselves. Another direction in which such

Co-operative Societies can work, is to supply the cultivators with cheap reliable manures. As this subject is in some respects the most important and at the same time involving important considerations, we shall proceed now to discuss it in detail. Before making any serious attempts to increase the agricultural output in India, we should consider whether it is possible to do so ; if possible, whether it is not better to devote all our energies towards the introduction of manufacturing industries. Are the conditions of labour and capital such, that, encouraging one industry will only mean the discouraging and strangling of the other ? Last, but not least, shall we get customers for our agricultural output, supposing we can double it ? A careful consideration of all these questions will no doubt lead us to the conclusion that it is quite possible to develop our agricultural industries and at the same time start new manufacturing industries. A considerable amount of labour employed in agricultural pursuits, will be released with the introduction of better

methods of cultivation. Capital also seems scarce in the country at present, not because it does not exist but chiefly because it is not enterprising. The richer classes, and even the middle classes, are generally indifferent towards the agricultural and manufacturing industries, especially the former. Secondly, as regards the question of the disposal of our surplus produce, we must bear in mind two outstanding facts. First, that whereas it is possible in many lines of the manufacturing industries to reach a point of overproduction, it is almost impossible in the case of agricultural industries, especially those involving the necessaries of life. Of course the law of Demand and Supply affects the prices of the latter also. But any lowering of prices is almost invariably followed by greater consumption and greater demand, thus soon counterbalancing any overproduction. Hence it has been well said that the world is never much removed from dependence on the last harvest. Abundant harvests do not mean overproduction or in other words a permanent surplus; whereas, the failure of

crops even in one important agricultural country of the world produces widespread distress. This being the case, we shall now try to show the possibilities of India in regard to agricultural industries. In the first place, India possesses all sorts of climates, a great variety of soils, high mountain chains and an enormous coast line. These fortunate natural conditions, if properly utilised, would form a very valuable asset. It is a well known fact in agricultural science that the products of a country are limited by the prevailing climate. In India, however, this limitation almost does not exist. Many agricultural products which are suited only for a European climate, can be easily grown on the hill slopes of the Himalayas. Similarly, while some parts of India are very dry, there are others where an annual rainfall of 500 inches is common. Hence, continued and powerful attempts should be made to utilise these physical conditions. The extensive coast line, for instance, is capable of giving India a large export trade in fish products, even after satis-

fying internal demands. Instead of that dried fish, etc., are being imported largely in India at present from several foreign seaports. Among many other products of the same sort may be mentioned sugar and wines. The former, as we shall show later on, is quite capable of being produced largely in India. Instead of that it is being imported to the value of about 9 crores of rupees annually. Wines and spirits of a very high quality can be manufactured, and in fact are manufactured to a certain extent, in Kashmir. Still, we have to depend largely on the foreign product because there is no easy railway communication with Kashmir at present.

Fisheries, wine and sugar-making, however, do not strictly come under the category of agricultural industries, although the last two depend to a great extent on their corresponding agricultural industries. We shall, therefore, turn now to agricultural industries proper, discussing briefly their prospects and the directions in which they are capable of expanding.

Before proceeding with this subject we should try to realise clearly the present condition of the agricultural industries in India. We have already alluded to one aspect of the question, namely, the Labour problem. Another important point that has to be considered very carefully is the rising prices of the food stuffs in India. How far this is caused by our increasing export trade in them and by the substitution of other crops in India, is a question we need not discuss here. If the former is the cause an artificial discouragement by means of heavy export duties is not likely to benefit the poorer classes. It will only take away from their hands the means of buying food although it will perhaps lower its price. As regards the substitution of other crops, namely, jute, cotton, etc., in the place of food crops it is but natural as well as proper that the cultivators should grow the most paying crops they can afford to grow. The remedy lies rather in the improvement of methods of agriculture so as to increase the amount of production of almost each of the products without encroaching

on each other. In the succeeding Chapters we shall try to indicate how scientific principles and improved methods may be applied individually to each of the important crops of India.

RICE.

THE importance of rice, whether considered as an article of export or the principal food of the bulk of the population, cannot be denied. The total amount of rice exported annually is worth 18 or 19 crores of rupees, which is about one-tenth of the total output of this cereal in India. Even this enormous output, gigantic as it is, is capable of considerable expansion. It is hardly possible to discuss within the space of an article the many directions in which improvement is possible. We shall simply, therefore, try to indicate generally some possibilities of this great agricultural industry of India.

It is scarcely necessary to point out that if improved agricultural methods can increase the output of this grain in India by five or ten per cent., the effect will be considerable. For assuming that the export trade of rice consists of the surplus produce, it will bring in about 18

or 19 crores of rupees more into the pockets of the ryots every year. If, on the other hand, the increased output is consumed within the country, the prices of food-stuffs will be lowered appreciably, bringing relief to millions of people.

The success or failure of crops depend to a great extent on the manure used, and rice is not an exception to this rule. Careful experiments carried out in America have shown that, whereas the yield per acre on unmanured lands was about 990 lbs., it was doubled with the aid of potash, acid phosphate and cotton seed meal manures. On lands where the last two manures only were used, the output was 1,320 lbs. But the use of suitable manures not only increases the output, but also makes the grain heavier and hence more valuable. It has been found that the product of well manured fields is heavier by about 4 lbs. more to the bushel than the ordinary product.

It is hardly possible to understand properly the subject of rice fertilization without knowing the chemical composition of this grain. It is

also essential to keep this in mind before employing manures, or taking any steps to prevent soil exhaustion. One thousand pounds of rice contain about 12 lbs. of nitrogen, about 1·6 lbs. of potash and 3·2 lbs. of phosphoric acid. Besides this, the same weight of rice straw contains about 7·5 lbs. of nitrogen, 4·25 lbs. of potash and 2·5 lbs. of phosphoric acid. From this basis we can calculate what the total yield per acre of rice and straw would remove from the soil foods in the form of nitrogen, &c. Hence the necessary quantity of manures could be estimated scientifically, provided we also take into consideration the use made of the straw. If the straw is used as a food for the cattle on the farm and returned to the soil in the form of farmyard manure, a correspondingly lesser quantity of chemical manures would be required.

The second point to be considered is the proportion of straw to the rice. Careful observations have shown that the amount per every 100 lbs. of rice varies from 150 to 250 lbs. This, of course, depends on the height at which

it is cut. The disadvantage of having a large proportion of straw is, that it exhausts the soil, without paying a sufficient return to the cultivator. It has also been found possible to lower the proportion of husk to the grain with the help of scientific methods and improved machines. Statistics indicate that in America, during milling, about 1 lb. of husk is removed from 5 lbs. of paddy; whereas in India the corresponding figures are about 2 lbs. out of 6 lbs.

The considerations mentioned about are merely general and do not involve any highly scientific training in agriculture. But the crude methods of our cultivators, in spite of the fact that this industry is being carried on in this country from immemorial ages, are capable of considerable improvement. An elementary knowledge of scientific agriculture, if it becomes general in India, will soon be followed by wonderful results.

So far we have discussed this question simply from the point of view of the cultivator. But rice also bulks largely in our foreign exports.

In 1904-05, about forty-nine-and-a-half million hundredweights of rice were exported, bringing in about nineteen-and-a-half crores of rupees. In 1906-07, about 39 millions of hundredweights were exported, bringing in about 18·5 crores of rupees. These figures, and similar figures of 1907-08, when the prices were high, go to show that the price of Indian rice in the foreign market varies from about 1 shilling 9 pence per bushel to 4 shillings. On the other hand, the price of American rice fluctuates between 2/6 and 4/10 per bushel. Hence attempts should also be made to obtain a better price for our product in the foreign markets. This can only be done by suiting our article to these markets. It is said that the last process to which American rice is subjected before placing on the market consists in polishing. This gives the grain a kind of pearly lustre and increases its value in the eyes of the purchaser. This process is very simple and consists of covering the grain with a thin coating of paraffin and passing soft pieces of skin over them.

Another thing to which attention should be paid is the improvement in the quality of the grain. It is well known that rice varies in quality and price enormously. A bushel of ordinary rice may be worth about one rupee, whereas the same quantity of superior rice would fetch nearly five rupees. Cultivators generally prefer to grow the inferior sort of the grain, because they largely grow it for personal consumption, rather than as an article of merchandise. Besides this, the initial cost of growing superior rice and the difficulty of finding a market for it, acts as a discouragement. The extension of the railway system and the development of the foreign trade of the country will remove the latter difficulty whereas the former can only be met with by mercantile farming. Unless capitalists turn their attention to scientific farming on a large scale, any considerable improvements in the agricultural industries of this country can hardly be hoped for.

Lastly, great beneficial results may follow if the recent experiments of Mr. Smith, the Deputy Director of Agriculture, Bengal, prove

practically successful. His experiments indicate that it is quite possible to grow a crop of paddy in rotation with jute, in the same year. If this is practicable without the risk of rapid soil exhaustion, the output of the grain can be increased in this country enormously, and thus increase the income of the cultivator, as well as benefit the consumer, by lowering the high prices of this necessary product.

WHEAT.

Wheat may be regarded as the grain next in importance to rice in India. The exports of wheat amount to about 10 crores of rupees annually. In 1907 they suffered a decrease of over a crore of rupees. Whether India will gradually lose its export trade in wheat, or on the contrary, it is capable of expanding is a question indirectly throwing light on many sides of the Indian system of agriculture. The first thing that strikes an observer is the low percentage produced in India, compared with most of the other wheat-producing countries of the world. In India the average per acre is about 10 bushels, whereas in the United Kingdom, Germany, France and Canada, it is much higher. Experiments have proved that this (*i.e.*, 10 bushels) is the average production of land where either manuring or irrigation is insufficient or wanting. In spite of the fact that in England the soil as well as the climatic conditions are in favour of wheat growing, it

has been found possible to produce from 15 to 25 bushels of wheat per acre even in India, provided suitable manuring and irrigation are both present. The necessity of irrigation and good manures being thus demonstrated we have now to look to the means by which they could be provided.

It is hardly necessary to point out the fact that, whereas in England the normal condition of the soil is "wet" in India it is "dry". Hence in India the chief question, besides manuring is the supply of water to the land. In those parts of the country where the rainfall is good, irrigation is not required. In fact, in the opinion of some experts, irrigation in such districts is even harmful. But in those tracts where the rainfall is not sufficient two remedies are generally suggested. One is, of course, the construction of canals and other similar irrigation works. The other is the planting of trees and the preservation of forests in dry tracts. There is little doubt that trees by exercising a cooling effect on the atmosphere, tend to increase the rainfall both in quantity and distribution.

Many actual instances can be given of places where afforestation has increased the rainfall and the proportion of rainy days. Another important result of the supply of cheap fire-wood would be to enable the cultivators to make use of the farmyard manure instead of burning it.

An important point connected with the Indian wheat trade is, that it does not realise in the world's market a price equal to that of other, say, American wheat. The chief reasons why this is so are two. First, the percentage of dirt in it is high, and secondly, it is often mixed up with other sorts of inferior grain. As regards the first it is partly the result of the crude method of threshing the seeds in vogue in this country. But a conviction is growing that it is the system of carrying on this trade which is chiefly to blame. The fact that it is sold on the basis of fair average quality, that is, on the assumption of there being a certain amount of dirt in it (about 5°/₀) is believed to result in its deliberate adulteration. In order to overcome both the difficulties namely,

the inability of the cultivator to send perfectly pure wheat and the subsequent "doctoring" to which it is often subjected by some middle men, the adoption of the "elevator" system is being advised by several experts. This system of grading the seed and shipping it in bulk has already been successfully tried in Canada. At any rate some means should be adopted which would ensure for the Indian product its fair price in the foreign markets.

As regards cultivation and manuring it may also be stated that this crop is influenced, like any other crop, by the methods employed in growing it. There are on an average about 12,000 to 24,000 grains in one pound of wheat. This seems to depend on the soil and cultivation. There are about four distinct varieties and twenty-four minor varieties of this grain. The lighter kinds, *e.g.*, "Gangajali" in spite of its apparently huge size, is not heavier than the best kind namely "Dudhi" or "Daudi." One direction in which improvement is possible, is in the introduction of better varieties of this grain where inferior kinds are being grown

at present. Some success has already been achieved in this matter in our Presidency owing to the efforts of the Agricultural Department. Better varieties of the grain have now been spread over the wheat-growing parts of Bombay; these show a greater resistance to disease (rust).

Besides rotation and irrigation the thing which requires most attention of wheat-growers is the attack of insect pests. Mr. Maxwell Lefroy, the Imperial Entomologist, recommends that as a preventive, the insects should be provided with an alternative food, so that they do not eat the seedlings. The common weeds and grass would provide this, where it is possible to defer weeding until the seed is well established. As the plant grows in size and strength the insect does less damage.

A comparison with the average output per acre of wheat in other countries, at once leads us to the conclusion that the output in India is not satisfactory. The following are the figures (in bushels) of other leading wheat-producing countries.

The United States	13·5
Russia	9·4
Germany	26·8
Austria	16·8
Hungary	17·6
France	19·8
The United Kingdom	32·0

In India the average per acre of irrigated wheat is 940lbs. Unirrigated 784lbs. At 60lbs. a bushel this is equal to 13⅓ bushels; but Indian wheat is heavier than English wheat and 64lbs. per bushel would be nearer the mark. This would give an average of 12½ bushels for Bengal; for India as a whole it is 10 bushels per acre.

As one of the important items in our export trade this grain claims especial attention. A large export trade in wheat has sprung up only in recent years. But it developed rapidly, and in 1904-05 it reached the total of 2,150,000 tons out of a total output of nearly 8 million tons. In that year India took the first place as a contributor to the wheat supply of the United Kingdom. In 1906 it fell back to the fourth place,

the United States, Russia and Argentina, taking a higher place. The exports in 1906-07 were only 801,000 tons. It is possible that unless persistent efforts are made to keep up this trade, India will lose it as rapidly as it had conquered it.

COTTON.

The cotton trade of India, large as it is, has got many possibilities. The demand for raw cotton is not only enormous, but increasing. At present, India does not take her full share in supplying the world's markets with this indispensable product. The total output and consumption of cotton is estimated at 185,000,00 bales of 500lbs. each. Of this the United States supply about ten millions, or about 80 per cent. of the commercial demand for cotton. India, on the other hand, is producing about 3,800,000 bales of 400 lbs. each or about 3 million bales of 500 lbs. When we consider the fact that in India the average under cotton is not less than 19 millions the figures are astonishing. In the United States there are about 28 millions of acres under cotton, that is, about fifty per cent. more than the corresponding average in India, but the output is more than three times as much.

The other unsatisfactory feature of the cotton industry in India is the great inferiority of the product. In America the output of cotton is not only greater per acre, but is also of a better quality. Hence it commands a better price and is readily marketable. For the same reason even the United Kingdom has steadily diminished its offtake of Indian cotton during recent years. In the later eighties, Great Britain took between 30 to 40 per cent. of the cotton exported from India; it has now fallen to five or six per cent. only, America chiefly taking her place. Of the 3,900,000 bales required by the United Kingdom, India supplies about one lakh bales only, America 31 lakhs bales, while Egypt and other cotton-producing countries supply the rest.

The question therefore arises, can we grow American and Egyptian cotton on a large scale in India? Can we improve the quality and yield of our indigenous cotton by breeding, selection, suitable manuring, &c., or in other words by improved scientific methods? Hitherto attempts in these directions had almost inva-

riably failed ; especially the introduction of American cotton on a large scale was often tried without any success. But fortunately during the last two or three years, experiments with the Egyptian variety have given very encouraging results in Sindh. Experiments with tree cottons also have proved satisfactory especially with the Spence and Caravonica varieties. As regards hybridisation a new hybrid produced by crossing "Kumpta" with "Goghari" has turned out better than the ordinary "Broach" cotton.

That India can produce cotton of the best quality is a proposition hardly requiring any proof. The Dacca district once used to produce the finest cotton in the world, and the cloth made from it was famous for its great beauty and fineness. Cotton is an indigenous product of India and one which has long been cultivated in the country ; even Herodotus refers to it as a plant "which produces wool of a finer and better quality than that of sheep, and of which the natives make their clothes."

We have tried to show above that the cotton cultivation in India is capable of being improved in several directions, of which four claim most attention, namely, (1) Introduction of a better variety (2) Increasing the average output (3) Improving the quality of indigenous cotton and (4) Cultivation of tree cotton. Of these the first is perhaps most important and fraught with the greatest possibilities; we shall therefore try to discuss it more fully.

Experiments show that out of the four common varieties of Egyptian cotton, one, namely Mataffifi, can be grown on a large scale in Sindh. The Abasi variety yields a brilliant white lint, is stronger and finer, and lends itself to "Mercerisation," or the process by which a silk-like finish is put on the cotton texture, but it is less productive. Hence the former is more profitable from the point of view of the cultivator, and the latter from a manufacturer's point of view. The best stapled and highest priced variety, namely, Yanowich, is perhaps too delicate for India. The fourth and the coarsest variety, Ashmorin, has not been tried successfully

in Sindh yet. But as it matures in about five months it can probably be sown in June (in Sindh) and picked successfully before the season of frost commences. The best time for sowing the first two is the end of February or the beginning of March. The selection of seeds is also an important matter. In India all kinds of seeds are mixed up at the cotton gins and hence there is a tendency of their deteriorating gradually. It is essential that the best plants growing in the fields should be selected and seed sown from these alone. Another important point to be kept in view is that the plants should not be watered abundantly, especially when grown on impervious subsoils, since that stops the aeration of the soil, gives the sickly pale or yellow hue to the plants and causes, by the capillary action of the soil, salt efflorescence which renders the land sterile.

There exist several cotton diseases for which no remedy has been devised as yet. But whenever a remedy or a probable remedy is found its knowledge should be spread amongst the cultivators. For instance, a certain grass-

hopper which attacks not only the leaf of the plant, but also its stem, has been known to disappear after the second watering. The cause of a fungus which affects the cotton plant has been traced to over-manuring. With regard to this disease Dr. Butler, the Imperial Mycologist, is of opinion that plants affected by it should be pulled out and burnt, and the field not sown with cotton for three years. With regard to bollworm Mr. Lefroy is of opinion that as a rule when they increase, their parasites increase more rapidly and thus keep down their number. Hence, when they are found in or near old cotton plants the best plan is to burn the old cotton stalks and sow bhindi as a trap-crop, since the bollworm prefers it to cotton ; then parasites should also be reintroduced.

Irrigated cotton crops soon exhaust the soil. In Egypt, therefore "Berseem" or Egyptian clover is grown in rotation with the cotton plant. Attempts to grow this plant in Sindh, in 1905-06 failed. Renewed attempts have been made this year however, and are likely

to meet with success. If successful it will supply the place of cheap manure, being a leguminous plant. By preventing the weeds and clearing the fields and by supplying organic matter, it has the property of rendering light lands more retentive of moisture, and heavy lands more friable and easy to work. The high quality of Egyptian cotton grown in Sindh is proved by the fact that as high a count of yarn as 120's has been spun of it and some of the best Mulls and Jacconettes made of it.

The suitability of Sindh for growing cotton is proved also by the following statistics. In Sindh in 1904-05 the output of cotton amounted to 176 lbs. of lint per acre, in 1905-06 to 119 lbs., in 1906-07 to 253 lbs. Punjab's being respectively, 96, 38 and 101 lbs. Madras's 31,36 and 40 lbs. All India's average being 77, 65 and 88 lbs. Sindh's output being exceeded only by Ajmere with 580 lbs, which is the best average yield in the world.

Coming now to low average output (2) in India we find that in 1905-06 it was only 56 lbs. In 1906-07 it was 88 lbs. which is

the highest on record. But in the same year the average in America was 233 lbs. This low yield is not only bad in itself, but is also assigned as one of the causes of the gradual disappearance of the famous Dacca Cotton. Its cultivation gradually went out of use because it was not very remunerative to the cultivators, the soil and climate of Bengal being more suitable for other more remunerative crops. The famous Photee of Bengal yielded on an average about 9 maunds of seed cotton per acre. Taking one fourth of this as the lint, the fibre amounted to 180 lbs. only. This yield, though much higher than the average yield of India (80 lbs.) is less remunerative than Jute. One hundred and eighty pounds of ordinary Indian Cotton would hardly be worth Rs. 45 whereas the same area sown with Jute would bring in more than Rs. 100 to the cultivator. The average yield of Jute per acre is 15 maunds of fibre *i.e.*, at Rs. 8 per maund, Rs. 120.

(3) The improvement in the quality of the indigenous cotton may be done in two or

three ways. First, by the carrying of the best Indian types to places where they are either not known or not cultivated at the present day. This has already been done to a certain extent by the introduction of "Broach" cotton into Dharwar District. Secondly, by carefully combining different strains of a variety and thereby producing one of better quality. Thirdly, by preventing two causes of deterioration, namely, want of selection by the cultivators and the mixing of varieties which take place at the gin; this may be prevented to a certain extent by giving instructions in the principles of selection of cotton for seed. Fourthly, by the cultivation on a large scale of the hardy cotton tree. We have already said above that some success has been achieved even now in all these directions.

To sum up, it is proved that superior cotton can be grown on a large scale in India; that the quality and yield of indigenous cotton can be improved; the only question now is not the possibility, but the required skill and capital for cultivating it. A well-known

planter referring particularly to the Sindh cultivators says that they are intelligent and capable of grasping the most intricate details of cultivation. But being illiterate and improvident, they require primary education. We shall deal with this aspect of the question more fully elsewhere.

SUGAR CANE.

There is perhaps no other agricultural industry in India which possesses so great potentialities and yet is so very neglected, as the sugar cane industry. Sugar cane may be regarded as the typical product of India and there is little doubt that this country is the parent of the sugar cane cultivation of the world. But in spite of this fact instead of exporting sugar as we did formerly, we are now importing it in enormous, and increasing quantities every year. The imports of sugar in 1904, 1905 and 1906 were 6·90 crores, 7·77 crores, and 8·73 crores respectively. The neglect of the cultivators of this excellent crop is due to the fact that sugar cane growing though very remunerative if successful, its initial cost is high. Moreover this agricultural industry is to a great extent affected by the corresponding manufacturing industry of sugar-making. That industry has been in a bad way during the last

few years because locally-made sugar is unable to compete successfully with the cheaper foreign product. This is very regrettable, especially in view of the fact that sugar cane cultivation is capable of being extended enormously in India. Moreover, in the words of Sir John Hewett, (Lieutenant Governor, United Provinces,) " there is probably no industry carried on in this country which is relatively so far behind as that of sugar . . . . . We should remember that at the present moment Java can produce refined sugar more cheaply than India can, and that there is no possible reason why she should do so if India did her best. No one would contend for a moment that a foreign country could supply the Indian consumers with a low grade sugar for eating purposes so economically as the domestic producer ; and if this be admitted, it should follow that no foreign country can, if our sugar industry is properly organised, produce refined sugar as cheaply as we can".

It must be remembered that sugar cane of some variety or other can be grown

almost in any soil, if it is irrigated and provided with subsoil drainage. The cost of cultivation comes to about Rs. 325 per acre and the gross outturn is worth about Rs. 560. Ordinary cultivators, through their ignorance of scientific principles, are inclined to apply too much manuring and irrigation. The result is that the cost of cultivation is increased and at the same time there is a decrease in the outturn, thereby often rendering the time and trouble spent over it nugatory. Attention should also be paid to the rotation of crops, and sugar cane should not be cultivated in the same ground except at an interval of about four years. Exception however may be made when powerful artificial manures are applied, *i. e.*, in the case of intensive cultivation, to which we shall refer later.

We have already referred to the fact that India instead of exporting sugar, is importing it in enormous quantities. The total annual consumption of sugar in the world is estimated at about, 41,55,000 tons, of which 16,42,000 tons are consumed in the United Kingdom. These

figures clearly show that, provided scientific and improved methods are adopted, India may one day develop a huge export trade in sugar.

Recently machines have been invented which increase the proportion of extracted sugar in the juice and thereby lessen the cost of making. Besides this, sugar cane yielding 70 per cent. of juice yields about 10 per cent. of alcohol; the cost of making alcohol is trifling, as waste steam is utilised for both pumping and distilling it. The outer grassy fibre of the cane is now used as fuel, and as such it is hardly worth more than Rs. 6 per ton. It has now been found that it is quite suitable for making pulp for paper. If so used,it can easily realise Rs. 75 per ton. Hence the possibilities of the manufacture of paper and alcohol as by-products of sugar, deserve careful consideration. In these days of keen competition a proper use of by-products often makes an unremunerative industry profitable, and America partly owes her industrial prosperity to a timely recognition of this fact. It is now generally recognised in the industrial world.

Many examples can be given of the beneficial results which follow from the adoption of improved scientific methods, one of them being that of Hawaii.

The production of sugar cane in Hawaii, since the introduction of improved methods of culture, irrigation and fertilization of the soil, has shown a gradual increase from 1,31,000 tons in 1894-95 to 3,90,000 in 1906-07.

Through a systematic study of the conditions in the different parts of the country, and the inauguration of field experiments with the different varieties, and the various treatments as regards fertilization and irrigation much light is thrown on the subject, not only from a theoretical point of view, but also from the standpoint of a planter.

One of the most important considerations besides proper preparation of the soil, opening of furrows, depth of plantings, size of cuttings, is irrigation. In Hawaii the exact amount of water necessary for the maximum production of sugar cane is now being determined to a nicety. Different opinions are held there

in regard to the effect of fresh and salt water irrigation, due to different soils and climatic conditions. In some instances the sea water salts have shown a beneficial effect, probably by releasing plant food, particularly potash from the soil, but in other cases saline irrigation has proved positively harmful. Regulating the amount of rain-water applied, is a question of difficulty, inasmuch as the average annual rainfall of one part of the country may be 5 inches only, whereas in other parts it is over 300 inches. The texture of the soil is also different, in different localities; this also necessitates different methods of cultivation; for instance, artificial irrigation is necessary on some lands, whilst it is superfluous and even harmful in others.

It may be noted that a copious rainfall is sometimes instrumental in carrying off potash and lime ingredients thereby making the soil poor. The use of appropriate fertilizers have a marked effect on the output of sugar; whereas formerly it was 6,300 lbs. per acre in Hawaii, it is now 10,080 lbs. This result is

of course, also partly due to a greater amount of juice and sucrose being obtained from the cane by means of better processes of refining. One reason why sugar cane requires suitable and liberal manuring is that it removes a considerable amount of plant-food from the soil; an analysis of the plant shows that a crop of one ton of sugar removes approximately 13·6 lbs. of phosphoric acid, 114 lbs. of potash, 40·5 lbs. of nitrogen acid, 35 lbs. of lime. The main object of manuring is therefore to restore them to the soil when they are removed, and to bring them in the soil when they are naturally absent. Some portion of these ingredients are restored to the soil by means of natural processes, but an average of 1,000 lbs. of fertilizers per acre has been found useful as well as profitable. These fertilizers should contain ammonia, phosphoric acid, potash and nitrogen according to the different requirements of the case. The tendency in America however, is to increase the amount of potash and nitrogen and decrease the proportion of phosphoric acid. Such intensive cultivation, by means of a liberal use of fertilizers has proved very beneficial in some places.

JUTE.

One of the many directions in which the development of Indian agriculture is possible, the introduction of new plants, is by no means the least important. The establishment of a new agricultural industry may be very laborious at first; it may not be paying during its early stages; but by developing it carefully and persistently it may possibly attain the stage of a gigantic industry; an actual example of this is the jute industry.

When it was started in 1828, jute worth £62 was produced. Within the next fifty years the outturn reached £ 5,000,000; and now it is not less than £ 27,000,000. This outturn, enormous as it is, may still further be increased, as India holds a virtual monopoly of this product. In the opinion of the Jute Specialist to the Government of Eastern Bengal, there are extensive areas in Bombay, Madras, the Central Provinces and Assam which may

prove suitable for this industry. A plot sown with jute in Poona yielded 608 lbs. of jute fibre, worth about Rs. 60, or fifty per cent. of the average yield of Bengal. Besides this the soil of Lower Sind is said to be particularly suitable for this while the extensive system of irrigation existing there, may prove a substitute for a well distributed rainfall necessary for its cultivation.

While cultivating jute or some of its substitutes, the chief thing to be remembered is, that the fibre is more valuable in proportion as it contains more cellulose. Jute of a good quality contains about 80 per cent. of cellulose, whereas inferior substitutes, for instance, *Hibiscus Esculentus* contains about 72 per cent. Hence it commands a price equivalent to about two-thirds of the ruling price of jute. For instance, when medium jute is at £24 per ton, its substitute fetches about £18. Similarly when good jute is available at £14 per ton, an inferior substitute would sell at about £9. It is also important to bear in mind that jute (or its substitute) should not be "either overretted" or insufficiently cleaned

as it makes it brittle and less able to resist the action of water. Another aspect of the jute industry as conducted at present, is also very important and deserves careful consideration. Jute is no doubt a very paying crop and hence in the eyes of the cultivator a crop more desirable than either rice or cotton. Hence it is now grown in many places where rice was grown before. It is believed in many quarters that this is one of the causes of the rising prices of food-stuffs in India. Of course it is only reasonable and proper that the ryot should grow that crop which is most paying to him. But at the same time steps should be taken to combat the evil indirectly arising out of it. Experiments tend to show that this can be done in two ways:—(1) By growing paddy in rotation with jute in the same year, and (2) by increasing the output of jute per acre with the help of more scientific methods of cultivation. We have already alluded to the first, while speaking of rice; we shall now proceed to give some actual figures:—

If jute is sown in the beginning of May, it can

be harvested in the beginning of August: whereas paddy may be transplanted in the third week of August and harvested in December. With careful treatment the outturn of paddy (fine) may be about 13 maunds and jute fibre about 18 maunds per acre. This would give a net profit of about Rs. 150 per acre, a very remunerative sum.

If the method alluded to above involves the risk of a rapid soil exhaustion, the second suggestion may be followed. Recent experiments at Burdwan have shown that the area under jute cultivation may gradually be cut down by half without lowering the total output. Putting it the other way, the output may be doubled without increasing the area under this crop. At present the average output per acre is 3 bales. With better methods of preparing the ground, sowing the seed, transplanting, cutting and steeping, the off-take can be doubled. Even if it can be increased by one bale per acre, the cultivators will receive nearly fourteen crores of rupees more annually. A beginning may be made by

jute mill-owners, or large exporters, who might take up land and cultivate jute on scientific principles. Investigations have shown that even the use of suitable manures can increase the outturn by about twenty per cent. Attention should also be paid to the different stages of growth during which the fibre is obtained as the quality and yield are no doubt affected by it. The following figures throw some light on this question. It has been found by experiments that the average yield of fibre per acre is as follows :—

			Mds.
Before flowering	...	...	15
In flower bud	...	...	20¾
In flower	...	...	24
When fruits are formed	...	...	25½
When fruits are dead ripe		...	26½

That is, the longer the crop is allowed to grow the larger is the outturn of the fibre. There is little difference in the quality of the fibre in the last four stages. Hence considering, especially the supply of water for retting purposes the fourth stage is the best.

The substitutes of jute are generally of an inferior composition, one prominent exception being the Birella fibre, (*Sida Rhombifolia*) the composition of which is similar to that of jute. It is a fibre, fine and silky, and very white in colour. It is capable of being used as a substitute for the finest jute and for mixing with silk. With jute at £20 its price may be put at £25 to £30 per ton. The plant deserves to be brought to the notice of the cultivators.

OIL-SEEDS.

The export trade in oil-seeds is also very large (worth nearly 13 crores annually) and shows no signs of decrease. The regrettable features of this trade, from our point of view, are twofold. One, that on general economic principles the export trade in raw materials is bad, provided it is possible to turn it into a trade in manufactured or even partly manufactured articles. It takes away from the hands of a large number of people the opportunities of profitable employment. Moreover, the same raw materials often return in the form of finished products and the customers have to pay freight both ways, the profits of middlemen and manufacturers and the wages of the skilled labour employed on them. If instead of exporting raw oil-seeds, we should turn them previously into oils, this industry would act beneficially in several ways. In the first place, it would give employment to a host

of people ; secondly, cheap oil would encourage several other industries, for instance, soap-making, candle-making, &c. Thirdly, the oil cakes will provide a large quantity of cheap manure.

Another direction in which improvement in this branch of Indian agriculture is desirable is the cultivation of the best varieties of seed. The price of oil-seeds grown in different districts of India vary greatly, owing to the different varieties of seed. If the superior varieties are introduced into those tracts where the inferior types are now grown, the cultivators will reap a material profit. Experiments have shown that this is not only possible, but practicable.

Refined cotton seed oil is now used for edible purposes in some parts of Europe, and the oil cake is utilised as manure. The great difference between the price of this oil and cotton seed is noticeable. While linseed sells for Rs. 8-7, gingelly for Rs. 7-0 and ground-nuts for Rs. 7-2, cotton seed sells only for about Rs. 2-4 per cwt. in Bombay.

Refined cotton seed oil is an excellent substitute for the usual vegetable oils used in cooking. Moreover in Hull undecorticated cotton seed cake sells at a higher price than the seed itself in Bombay. As a cattle food its value is already established. It may be noticed that the United States produces about 3 million barrels of 50 gallons each, of the crude oil. It contains resinous matter, albumin, mucilage, moisture and free fatty acids. The colour varies from light claret to almost black. The resinous matter is soluble in spirit and alkalis ; it (*i.e.*, the alkaline solution) contains great colouring powers but is valueless as a dye.

The refining is generally carried on by means of caustic soda because it has the power of neutralising the free acids, coagulating the albumin, and dissolving away the colouring matter. The process is carried on in large tanks ; the sediment which settles down is used as a basis for making various textile soaps. The remaining refined oil, about 90 per cent. is of a pale yellow colour and is sweet and neutral to the taste.

Linseed and mustard seed are treated almost in the same manner. If attempts are made to utilise the possibilities of cotton seed, linseed and mustard seed in this country, the agriculturists will reap a special benefit. They will receive the same material benefit that they are getting from the export trade in oil-seeds, and at the same time they will get cheap fodder and cheap manure.

ACACIA.

As an example of the immense possibilities of agricultural improvement in India, it may be stated that there are many plants in this country which are absolutely neglected at present, although they are full of potentialities. One of them is the Acacia. The bark of these plants contains many valuable substances, chief among them being tannin. When it is remembered that the tropical acacias form a large and well-distributed group of plants, it will be realized that the available tannin from this source alone, is enormous indeed. Nevertheless, out of about 18 indigenous species, the barks of only two of these are commercially utilized ; these are the acacia *arabica*, and acacia catechu (Khair). Even the above are not fully utilized, as we shall endeavour to show presently : the former, if properly treated, is capable of producing about 168 pounds of tannin, *i. e.*, at the

rate of 15 per cent. an average of half a ton of bark. The best age at which the bark is mature and of a good quality is, according to a competent authority, ten years.

The acacia catechu, as its name denotes, produces catechu, or catechu-tannin. Still no endeavour has been made as yet to utilize its product, on a large scale, for tanning purposes. To obtain the catechu the tree is felled and its heart-wood cut up into chips and boiled. The bark however with its stores of tannin, is usually left to rot in the ground. Some idea of the extent to which this wastage of a useful and valuable raw material now takes place in the country may be gained from the fact that throughout the wide area of its distribution thousands of trees are annually felled.

WATTLE BARKS (MIMOSA BARKS).

These are derived from Acacia ; most prized and richest in tannin is the Acacia Pycnantha (Golden Wattle). In Natal however Acacia Mollissima (Black Wattle) is preferred for planting, being hardier and giving on the whole, a better yield of bark. Although Black Wattle will grow in practically any kind of soil, a friable sandy loam answers best, a soil which retains moisture being most suitable for its culture. The plants are grown from seed and no special precautions are necessary for the sowing.

After germination the plants grow quickly and attain a height of over 25 feet in about four years. The bark yields tannin, and the wood is believed to be capable of being used in paper manufacture, acetic acid, and wood alcohol. The bark is valued at £5-10 to £9 per ton. Australia exports over 12,000 tons. and Natal 15,000 tons of this bark every year,

the chief markets being London and Hamburg. Bark in good condition and undamaged by weather or wet packing is readily saleable, even damaged bark being saleable, as a rule, in Hamburg. Recently, however, there has been a tendency to use the extract of the bark for tanning purposes, instead of the ground bark. From the point of view of producers it would be more profitable to export the extract, instead of the bark. This would effect a saving in freight and would enable the growers to utilize inferior barks containing a lower percentage of tannin. The extract can be exported either in a liquid or a solid form, the latter being preferable when it can be prepared without the risk of decomposition. The extract should be prepared in such a way as to obtain the maximum amount of tanning and the minimum amount of colour and moisture, since the latter (water) has to be evaporated later on.

SUNN HEMP.

Sunn Hemp requires no irrigation. It is usually grown on clayey, sandy soil (paddy land) in the Tavoy District of Burma. The mode of preparing the land consists in burning the paddy straw, and then clearing the land of paddy stalks. The land is next carefully ploughed and then trodden by a herd of buffaloes in order to break the clods. The seeds are then sown broadcast towards the end of December and the crop is ready in March or April for reaping. When the seed-pods have become quite dry the plants are stripped of their leaves, seeds and roots, and cut into lengths of about two feet. These are gathered into bundles and buried in the mud on the river bank just below high watermark. When they have become sufficiently rotten they are taken out, the stalks are beaten until the bark is removed. The white stalks are now stood in the sun to dry. The quantity

required to sow an acre of land is one paddy basket of seeds, costing Rs. 5, the cost of sowing being about Rs. 4, *i. e.*, Rs. 9, in all, the outturn per acre being fibre worth from Rs. 8 to 15, plus three baskets of seeds. It is believed in Tavoy that brackish water assists in separating the bark from stem, but it is by no means essential to its growth. It has also been noticed that these two crops (hemp and paddy) are produced without any exhaustion of the soil. But this is perhaps due to three reasons:—(1) The lands in Burma where it is grown are exceptionally fertile. (2) Paddy and hemp require different constituents for their growth. (3) They are yearly enriched by inundations which leave behind a valuable deposit of silt.

At present a very small area is grown with sunn hemp and the produce is consumed locally in making and mending ropes and nets used in the local fishing industry. It can be safely marketed at from £16 to £20 per ton. It might form either a second crop on the richer

lands or a dry weather crop on lands which are too deeply inundated for paddy cultivation. With a growing demand for raw materials for the manufacture of cordage, ropes, gunnies, &c., the cultivation of sunn hemp in other parts of India should prove profitable.

CAMPHOR.

Among new plants which may profitably be introduced in India, the camphor tree deserves particular mention. The demand for camphor is steadily increasing, and the price has consequently risen enormously during the last ten years. Besides this, the output is also limited at present, camphor being practically a monopoly in the hands of the Japanese Government. Hence, for many years to come, an increased output of this product is not likely to force down the prices to a low level and make the industry unprofitable.

The term "Camphors" is applied generally to several aromatic plants, but the tree we are discussing here is the well-known Japanese laurel, product of the *Cinnamomum Camphora*. The natural habitat of the plant is the eastern slopes of Asia extending from Cochin China to Shanghai and in the islands from Hainan to South Japan. It grows wild on the mountains of Formosa up to an altitude of

2,000 feet. It is a large tree growing to a height of 100 feet and with a stem from two to three feet in diameter; the leaves are laurel-like and emit a strong smell when crumpled in the hand. The wood is also much valued on account of its odour, and largely used in Japan and China for making articles of furniture.

The camphor tree can be grown at different altitudes and under various climatic conditions. In Ceylon, it has been grown successfully at a height only a hundred feet over sea-level, as well as near Newara-Eliya, at an elevation of about 5,000 feet. But a well drained deep sandy loam, and a fairly copious rainfall, are conditions favourable for its rapid growth.

The plant may be propagated in various ways:—(1) from the seed, (2) by means of layerings, (3) branch cuttings, (4) root cuttings or (5) suckers. The best method is that of raising from the seed; but it is often unsuccessful because seeds loose their vitality in four or five months. Care should be taken therefore to obtain fresh and mature seeds from Japan, which are available in November.

It would appear from what we have stated above that the prospects of growing this plant on a large scale in India are promising. In fact this tree is already found in various places in Burma, but particularly on mountain sides and other places protected from the winds.

The methods of making camphor are also very simple ; the two methods generally followed are as follows :—(1) The leaves are put in a large vessel containing water and placed on fire. When the water begins to boil a copper lid is placed on the vessel, care being taken to keep it constantly cool. After some time a white layer of camphor is formed on the inner side of the lid which is scraped off, and the operation repeated 8 times during one day. In orderto crystallise it, the camphor is exposed to the action of the open air. (2) Another method of distillation is as follows :—The leaves and twigs are placed in a bamboo basket, and it is floated on a large vessel containing water ; as a condenser a chatty of cold water is placed on the top, the water being frequently changed. Heat is applied for a few

hours and then the leaves are removed. Camphor is now found sticking to the sides of the basket.

The estimated world's consumption of camphor is over 10 million lbs. annually, the present price being about £20 per cwt. Japan holds the monopoly at present but there is no reason why India should not enter into competition. At any rate attempts should be made to meet the local demand, which is fairly large.

Attention should also be paid to other varieties of the camphor trees, particularly, the *Blumea Balsamifera*, which yields a product similar to camphor. Competition with synthetic camphor need not be feared for many years, because the cost of making it is high, and the product perhaps not so good as natural camphor.

LEMON GRASS OIL.

Lemon Grass is found in private gardens scattered all over India, but its commercial value is evidently not known in any part of India, except Madras. In Ceylon, it is largely grown for its oil. Even Madras exports about 12,000 gallons of the oil, worth about Rs. 4,80,000 annually. The Indian Lemon Grass Oil is superior to the West Indies and Brazilian product, inasmuch as, it is easily soluble in alcohol, whereas the latter is not. It is more valuable, therefore, as a basis in the manufacture of perfumery, and if the industry is started in other parts of the country also, it is sure to be profitable.

The grass can be grown almost in any kind of soil, and at different elevations varying from sea-level to about 2,000 feet, and perhaps even at higher altitudes. The rootlet should be selected from well grown plants, from two to three years' old. They can be

grown at any time of the year, provided, they are regularly watered, but for planting, the rainy season is the best. The stools should be divided into slips, and planted in holes at distances from two to three feet apart. Attention should be paid to drainage and weeding. Manuring though beneficial is not essential. The grass grows rapidly, being ready for cutting and distillation, in about six months after planting. After that three cuttings can be taken in each year, the highest yield being in the third year. After three years the stools require replanting.

The distillation is generally done by steam, the yield of oil being about 20 per cent. The crude oil is of a pale or dark yellow colour, and contains from 50 to 74 per cent. of citral; it is more valuable in proportion as it contains more citral. After extraction, it is filtered, first through a piece of cloth and then through filter paper. It is then filled in bottles, tins or casks and sealed. The value of the pure oil in the English and Continental markets varies from Rs. 1-8 to Rs. 8 per lb.

It is used for perfuming soaps and pomades, for making perfumeries, for adulterating verbena oil, and as a medical oil.

We have referred above to several typical, agricultural plants which already exist in India, but are not exploited, at any rate not extensively grown or exploited, for commercial purposes. There exist, no doubt, many other plants, which are capable of becoming the basis of large agricultural industries. A patient and persevering work in this direction, aided with the light of science, is likely to bear much fruit. We shall now proceed to deal with another important question, namely, the introduction of new plants; we shall content ourselves with giving a list of only a few typical new plants and their methods of growing in other countries. There are many plants which can be grown in India successfully and profitably, but instead of that their products are imported largely from other countries, at the present day. It may be said generally that there does not exist any plant which cannot be grown *somewhere* in India. The

fact that they are not cultivated at present is due, either to the ignorance of scientific principles on the part of the cultivators, or owing to the unenterprising character of the Indian capitalists. We shall therefore deal somewhat fully with a few agricultural products which are hardly cultivated in this country at present but which are full of enormous possibilities. We shall treat of "Ramie" first, as possessing perhaps the greatest potentialities. While discussing the possibilities of this plant we must constantly bear in mind the fact that the first experiments with new plants, almost always end in failures. Jute, from a trifling beginning eighty years back, has now reached gigantic proportions. Similarly experiments with the cultivation of superior cotton on a large scale in India, invariably met with failures, until the last two or three years.

RAMIE.

The virtues of this fibre have been known in this country, since the beginning of the 19th century but hitherto almost all attempts at its successful and profitable cultivation have met with failure.

Dr. Royle, the Superintendent of the Botanic Gardens at Sahranpur, in his excellent work, "The Fibrous Plants of India," says: "Though the beautiful fabric known as China grass cloth has long been well-known, the plant producing it was long unknown. When imported into this country (*i. e.*, England) it sold for £60 to £120 a ton. * It can be had at Ningapo at 6 dollars a picul of 133℔s. Three prize medals were awarded at the Exhibition of 1851 for beautiful specimens of this fibre."

An interesting article in the January (1907) number of the "Agricultural Journal of India" throws much light on this important subject. The writer, Mr. Bernard Coventry, being the Director of the Agricultural Research Institute,

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* Dr. Royle's work was published in 1855.

Pusa, may properly be regarded as a very reliable authority on this subject.

Mr. Coventry says that the efforts made by the East India Company to introduce rhea or ramie as a textile staple met with little success. The Indian Government renewed these attempts by offering handsome prizes of £5,000 and £2,000 in 1869 for machinery or processes suitable for this fibre. The prizes were again offered in 1877, but as no suitable machine was forthcoming, the offer was eventually withdrawn.

Experiments were carried on by several European planters and Companies, especially in the Madras Presidency, but with little success, because the outturn per acre was not sufficient even to pay for the expenses of cultivation on account of the low price which ramie commands at present in the market. The best outturn per acre was about 8 tons of green stems from which from 3½ to 6 per cent. of ribbons were obtained. As these ribbons contain only about 30 per cent. of fibres, the rest being cuticle and gum, the actual yield varying from about 1 to 2 per cent. only.

Mr. Coventry is of opinion that the cultivation of rhea would be profitable if a green crop of about 15 tons could be obtained per acre. On the assumption that the yield of dry fibre would be about 2½ per cent., Mr. Coventry arrives at the following figures :—

Cost of producing one ton of fibre per annum from 3 acres :—

			Rs.
Cultivation and general charges at Rs. 20 per acre	...	...	60
Manuring at Rs. 15	...	...	45
4 cuttings at Rs. 3	...	...	9
Carting 45 tons of green stems at As. 6.			17
Decorticating at As. 9	...	...	25
Washing, drying and cleaning		...	20
Baling and despatching	...	...	12
Engine coals, &c.	...	...	30
Special establishment	...	...	20
Freight home and insurance		...	75
Total	...	Rs.	313
Price of 1 ton of fibre at £30...		„	450
Balance of profit	...	Rs.	137

This gives a profit of about Rs. 45 per acre.

The chief difficulty lies, therefore, in the lowness of the price it fetches at present. This is because there is little effective demand for the fibre. This is somewhat surprising when we consider the fact that the great utility of ramie as a cordage as well as a textile fibre is now established.

Perhaps the real solution of this difficulty lies in the hands of the manufacturers and spinners. If they offer a price which gives sufficient remuneration to the planters and cultivators, they will be encouraging an industry which has got great possibilities not only for the grower but also for themselves. Manila and aloe fibres fetch a price between £30 to £50, while flax from £40 to £100. Surely, therefore, ramie which is probably inferior to neither, would be cheap and very remunerative, even to the manufacturers if it could be had in large quantities for £40 per ton. It will be a matter of great satisfaction if some enterprising spinners in this country will lead the way by taking up the double task of the production of

this promising raw material as well as its consumption in their own factories. This will save them the profits of middle-men and give them the profits over the cost of production, thereby making their position doubly advantageous when once the industry is firmly established.

We may observe that a powerful ramie-growing Association, which has lately been formed in England, bestows a share of its attention upon India. In common with most attempts to revive interest in this ill-starred fibre, the Association owes much of its vitality to the indefatigable Mr. Edward's Radclyffe, of Staines. Mr. Radclyffe is trying hard to induce manufacturers on the one hand to employ ramie, and on the other, exhorting planters to put this crop in. A lady professes ability to prove that planters in India may grow ramie and sell clean strips in London at £15 a ton and make a profit. This lady is Mrs. Hart of the Bombay Woollen Mills Co., Gerrardst, London, W., whose technical successes in also manufacturing this fibre are said to have been

considerable. Most of the mantles for incandescent gas lighting are of ramie—its absorbent nature peculiarly befits it for reception of the minerals which incandesce—but that purpose can hardly ever use much material. A single pound of yarn is computed to make 700 mantles. Some cordage for driving machinery in moist atmospheres is made from ramie and it is recommended for underwear. Khaki drills of half ramie, and a limited number of other fabrics also gain acceptance.

But in spite of many failures in the past, there is every reason to hope that we shall be able some day to make ramie a paying product in India. The merits of ramie as a fibre are now generally recognised. The only difficulty is the high cost of production, due to the low percentage of dry fibre obtained at present. If this low percentage could be increased through the employment of better machinery and also through suitable improvements in the methods of cultivation, ramie would become a paying crop. Price is also an important factor in this question, but it is the

opinion of reliable experts that with increased output the demand for ramie will increase. This will consequently raise the price in spite of greater output. The great difficulty in connection with the use of ramie for textile purposes has been, the softening and degumming of the fibre. A process has been recently discovered by Mr. W. M. Smith of Shanghai, which easily renders the fibre degummed, bleached snow white, and almost like silk.

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RUBBER.

Amongst other agricultural industries which may possibly be introduced on a large scale in India, that of rubber planting also holds out good prospects. While considering this question, we must take into account the possible overproduction of this product. Statistics show that the total production and consumption of rubber reaches about 68,000 tons annually. Moreover, the consumption is increasing by about 10 per cent. annually, and is likely to reach 1,00,000 tons in a few years. The supply on the other hand from one principal source, namely, Brazil, has been almost stationary during recent years. Hence a fear of overproduction may be dismissed as groundless.

Even assuming that a great extension of the cultivation of rubber will lower its prevailing high prices, there is every reason to suppose that a rapidly growing demand will keep up the profits of this industry. Rubber will soon

be put to various uses for which it is peculiarly suitable. Rubber, pure as well as mixed with other ingredients, has been found very efficient for road paving. The chief reason why it is not used for that purpose at present is that it is very costly. Therefore, if its price is forced down through overproduction, a largely increased demand will soon compensate the planters. Thus, it may be confidently stated, that the present total area under rubber cultivation, (about 1,50,000 acres) may well be doubled gradually, without any immediate risk of overproduction.

Experiments were recently made in the Thana District, with ficus seeds obtained from Assam, and Castilloa, Hevea and Ceara seeds. The first gave a few healthy plants, and the ceara variety also germinated after some delay. The only practical result of the experiments was, that the possibility of growing the rubber tree in this Presidency was demonstrated.

The seed of the rubber tree, it should be noted, contains a hard shell, and a delay in germinat-

ing should not be taken as failure. As regards climatic conditions, a rainfall of 90 inches is believed to be necessary. With respect to composition, rubber usually contains about 92 per cent. of caoutchouc, 3 or 4 per cent. of resin and a small proportion of proteids and ash. A lower percentage of caoutchouc and a higher proportion of resin, makes it less valuable. Hence rubber trees should not be tapped until they reach maturity, which they do after eight or nine years. This leaves a gap between the time of planting and the time when the tree yields a payable latex. As a catch crop, cotton, groundnuts and camphor, are suggested, the last named being perhaps the best for that purpose. It possesses additional advantages as a preventer of weeds, and as a plant growing almost in any soil.

MINOR PRODUCTS.

Amongst minor products, spices, medicinal plants, fruit trees and potatoes need particular mention. Saffron, for instance, is a substance of high commercial value and has got a great demand. Many people are now unable to make use of it as a condiment on account of its high price. It is now largely imported from Persia, Egypt and Asiatic Turkey. It is grown, however, in Kashmir, and probably it can be cultivated in other parts of the Himalayas at an altitude of 6,000 ft. over sea-level. Many medicinal plants can be produced in this country, and some are already cultivated to a certain extent. The following may profitably be cultivated on a large scale, namely, Asafetida, rhubarb, henbane senna, and many others.

The production of turpentine oil also can be extended considerably. The Himalayan pines abound in turpentine ; they yield this oil by distillation, and a good quality of resin is left as a residue.

POTATOES.

It is rather amusing to find from last year's Report (1906-1907) of the sea-trade of Bombay that we are buying nearly four and-a-half lakhs' worth of potatoes from Italy every year. The reason appears to be that they find a ready market here when the local supply of Mahableshwar and other hill potatoes, ceases, on account of the rainy season. There is reason to believe, however, that the demand can well be supplied from other parts of the country, if attempts are made in that direction.

FRUIT TRADE.

A large and lucrative trade is carried on by certain countries in fruits, especially bananas, oranges and pine-apples. It is possible that with the aid of science India also may one day be able to develop a large trade in fruits. In view of this fact, perhaps it would be interesting to note the methods adopted by the American exporters:—The branches of the bananas are carefully brushed, enveloped in cotton wool, then in dry paper and placed in open octagonal wooden crates which freely admit air. The bottom of the crate is lined with hay, straw, maize leaves or banana leaves cut up and dried. Empty spaces are firmly stuffed to prevent oscillation during transit.

A Company with a capital of £ 3,00,000 was formed in London in 1907 to manufacture and deal in banana flour. Bananas were the saving of the Canaries when the cochineal industries were ruined by aniline dyes; and

they were the saving of the British West Indies, when the sugar industry was in a moribund condition owing to the subsidised competition of Continental beet sugar. Both the above countries have depended on the export of this fruit for the bulk of their revenues.

As regards India, it must be admitted that the chief consuming centres, namely, Great Britain, the Continent and America are too far away to make it profitable to export the fruit from this country at present. But with regard to the manufactured produce the case is different. The flour of the Banana is produced by simply peeling it when partly ripe, and drying it in the sun; after this it is reduced to a fine powder. The average yield of flour is about 20 per cent. in weight of the raw fruit. Several manufactured articles could be made of this flour, among them being banana, custard powder, banana cocoa, banana pastry flour, etc.

Several samples of the flour forwarded from India (Calicut), Seychelles, Venezuela, etc.,

were submitted to analysis at the Imperial Institute recently, and the result disclosed the fact that the Indian sample was superior in some respects to the other samples. Its diatetic value was found to be lower than wheat flour but higher than starches like arrowroot; but as a food for invalids and infants and as an article of luxury, it should command a ready sale.

As we have pointed out above, it will not be profitable to export, either the fruit or the flour to the United Kingdom at present. The market price there, is 18*s*. for the dried fruit, and from 16*s*. to 20*s*. per cwt. for the flour, the cost price of the latter being about 18*s*. in India to which one shilling should be added for freight, etc. But at the same time it should be noted that the retail price of 1 lb. packages of banana flour is about 5*d*. whereas, if exported from India they could be delivered there at about 3*d*. per lb.

Locally the industry would be even more profitable. In Calcutta the retail price of the flour is about rupee 1 per lb., and if the

merits of the banana flour are better known a large demand is sure to spring up.

Finally, when considering the possibilities of an export trade in fruits (*e. g.*, the mangoes) we must remember that the United Kingdom alone, imports bananas worth nearly a million and-a-half pounds yearly, the value of imported oranges being even greater.

Pine-apples are packed in a similar manner (to bananas) the method adopted in the Azores being as follows :—The stem is cut below the fruit, when the latter is beginning to turn yellow and the top is still green. Each fruit is wrapped in soft paper and six to eighteen fruits according to size are packed in one crate, which is lined with a layer of a kind of chaff of chopped-up maize leaves. In a crate containing eight, four are placed one in each corner and the other four in the centre taking care to cross them, so that the crown of one is side by side with the stem of the other, with a small space between adjacent fruit. Crevices are thoroughly stuffed with maize chaff and the same material is spread over all the

fruits, and the whole finally packed to prevent oscillation. Fruits must not project from the case, as the pressure would cause them to rot. They must on no account be bruised in picking or during packing. They must never be packed immediately after being picked, but should first be allowed to cool for one night.

THE INDIAN LAC INDUSTRY.

This is one of the ancient industries of India, and consists of two parts: (1) shellac and (2) lac-dye. But whereas the former is developing gradually, the latter has, gradually, almost disappeared. The reason assigned is, that the cultivation and collection of the latter was and practically is in the hands of the aboriginal tribes of the poorer parts of the country. Their methods of collection and propagation are, needless to say, very antiquated, the result being that our former large exports in lac-dye have now stopped almost entirely.

TEA AND COFFEE.

The cultivation of tea and coffee in India, so far as improved methods are concerned, leaves little to be desired. Our export trade in tea has been gradually increasing, and is now worth almost 10 crores, annually. The intrinsic merits of the Indian tea, combined with the energetic manner in which it is "pushed" in other countries, has enabled it to capture the markets formerly supplied by the Chinese product. There seems to be, however, even greater room for the expansion of the Indian Tea Trade. In 1896, the total consumption of tea was estimated at 576 millions of lbs. of which India supplied 150, China 240, Ceylon 110, and Japan 65. It is now believed to have reached 681 millions lbs., the exports from India being 236, from Ceylon 170, China 188, and Japan 56 millions of lbs. There is reason to hope that in the near future India will be able to supply about 50 per cent. of the total consumption.

The Indian coffee trade is not in a satisfactory condition, but the chief reason is that tea is now largely taking the place of coffee as a favourite beverage. India, at present, takes a minor place in supplying the world's markets with coffee, but, if necessary, large areas suitable for this industry are to be found in the Deccan. Experiments have shown that an output of 750 lbs. of coffee per acre can be obtained in the Poona and adjacent districts.

TOBACCO-GROWING IN INDIA.

Amongst minor agricultural industries in India, which give a fair promise of development, that of tobacco-growing is one of the foremost. Of course, so far as quantity is concerned, that already being grown in India is very large, but the quality of this tobacco is generally poor. It is true that high-class tobacco is now being produced in this country, especially in the Madras Presidency, but it is generally better suited for the manufacture of cigars only. There is little doubt that if persistent efforts are made, and better methods adopted, a general improvement in quality will result. If this happens, tobacco will soon form an important and increasing item in our export trade, and bring a large return to the country.

As we shall show now, the reasons why this industry has not developed in India yet, are twofold ; first, the ignorance of the ordinary

cultivator of better methods of cultivation, and, secondly, a successful tobacco-curing industry requires a heavy outlay of capital, as well as an extensive plantation.

Any one wishing to embark on this industry must supply himself with all the necessary buildings, &c., before planting the seeds, for any delay will result in the deterioration of this sensitive crop, thereby making all the trouble and outlay over it fruitless.

Roughly speaking, the whole process of growing and curing tobacco from first to last is as follows : The first requirement is a building where the leaf could be cured. It is stated by experts in this industry that this building should be so constructed as to be at right angles to the prevailing winds. If possible the site chosen should be on sloping ground, provided the slope is towards the direction of the wind. The ventilation should be chiefly through the floor. Another necessary building is the fermenting barn and sorting room. The fermenting room should be carefully constructed, and should be provided

with air-tight walls and floor. The temperature and moisture of both these rooms should be under perfect control, otherwise the quality of the tobacco will suffer deterioration while it is being sorted and baled. As we have said above, these necessary accessories should be provided before the seeding and planting is actually started.

As regards sowing it is better to use only the largest seeds. The soil for the seed-beds should be as rich as possible. The seeds should be scattered thinly and watered with a fine rose, and the surface of the bed should be kept wet though not quite soaked. Moreover, the seeds should not be covered with soil.

Amongst fertilizers the following are recommended. In the beginning, slaked lime, then a quantity of sulphate of potash and raw phosphate. Potash chloride should not be used as it has an injurious effect on the quality of the tobacco leaf.

While harvesting the crop the following points should be remembered: The tobacco

crop consists of three grades, filler, wrapper, and binder. The wrapper grade, which is the most valuable one as a commercial product, requires to be thin, elastic, and pale coloured. For this reason it should be harvested first and when it is still under-ripe. The medium grade, namely, the binder, may be taken out somewhat later, when the leaf has thickened a little. All the remaining leaves, when ripe, would, of course, serve as fillers.

In the curing and sorting rooms care should be taken not to overheat the leaves, otherwise they might turn black. They should be piled in such a way that the greenest leaves should be on the top, those that are slightly cured just below them, and so on. The process of curing is a difficult one and requires much care and experience. The object is to produce the yellow colouring. If care is not taken as regards heat and light the leaf grows either green or black.

When the process of curing is complete the tobacco leaves should be sorted according to grade and then taken to the fermenting room.

This is also a delicate process, the different grades requiring different treatment. During these operations one thing should be remembered. If it is necessary to moisten the leaves, the walls and the floor of the room should be wetted or hot steam turned on in the room, but water should not be applied direct to the leaves.

While baling and marketing the crop, care should be taken not to allow different grades to get mixed up, as the price realised corresponds to the lowest grade of leaf found in the bale.

Lastly, we should emphasise the fact that this industry is one of many other industries which the application of improved methods of agriculture has made very paying. Although tobacco is really speaking a luxury, it has a demand almost in all parts of the world. Its extensive production, say in India, might lower its price a little. But for many years to come it is sure to find a ready market in some country or other. It is probably an error to suppose that the finest quality of tobacco, say

Turkish, or Virginian, can be grown in these countries only. The natural conditions obtaining in them can be produced to a very great extent anywhere through a judicious adoption of scientific cultivation. For instance, the elasticity of the leaf is said to depend upon its state of maturity when it is harvested, its flavour upon the sun-light it receives, and its beautiful aroma upon the gumminess of the leaf. Similarly, its burning quantities are believed to be governed by the state of the soil in which it is cultivated. Needless to say, that all these conditions can be artificially varied and obtained even in this country to a considerable extent.

MANURES.

The possibilities of scientific methods of agriculture, thus lie in three directions : Firstly the increased output of staple crops already being grown in India, with the assistance of suitable manures, better implements, attention to the proper rotation of crops, selection and cultivation of best seeds, &c., secondly, commercial use of plants already growing in the country, but not utilised through ignorance or any other cause, at present, and thirdly, the introduction of new plants like ramie, which hold out possibilities. There is also another direction in which much useful work can be done, namely, the introduction of subsidiary industries, like sericulture, but of this we shall speak later on. Among those mentioned above, the increase of average output per acre, by means of suitable manures, is in some respects the most important and we shall therefore examine it somewhat more fully.

The subject of manuring may roughly be divided into three parts, namely, (1) Farm-yard manures. (2) The application of green manures, and (3) artificial manures. (I) Farm-yard manure is no doubt one of the cheapest and best manures, but its manuring properties are largely wasted through ignorance at present. It has been estimated that the annual total production of farm-yard manure, in the United Kingdom, is 40 million tons, worth £10,000,000. To replace by means of nitrate of soda the nitrogen that is lost by careless management would cost about £2,300,000 to £3,400,000! This gives us some idea of the wastage that may be taking place in an agricultural country like India, through an ignorance of scientific principles. The other fact which we must bear in mind, is, that cow-dung is generally used by the agriculturists as fuel. It is true that as a cheap and good fuel no substitute can be found for it. But if we take the value of cow-dung as a fuel at 4½ annas per maund and that of cow-dung ashes as manure at 3½

annas per maund, it will pay the ryot to use it as a manure and buy some other fuel ; for, the price of cow-dung as manure is not less than 11½ annas per maund.

II. As regards green manuring it may be stated at the outset that it is not unknown in India. It is practised in various parts of the country but is often unsuccessful through an ignorance of its scientific principles. Briefly speaking, green manuring consists of growing a leguminous crop (generally) and ploughing it into the soil at the time of flowering. Many cultivators know that by doing this a heavier staple crop can be obtained from the soil ; but the scientific explanation of the fact was discovered only a few years back, by a German Scientist. We now know that this is the result of nitrification of the soil. The plants of the pulse order have the power of absorbing more nitrogen from the air, than they require. They fertilise the soil by leaving the surplus nitrogen in it. Experiments have shewn that different staple crops, require different green manures, sesbania

grandiflora, for instance, is suitable for cocoa-nut and tobacco plants, groundnuts for tea, coffee and rubber plantations, &c. Besides this, the leguminous plants do not develop nodules at their roots, in certain soils. The result is that the plants abstract nitrogen instead of adding it to the soil. Thus an empirical use of green manures may often be very injurious.

Thirdly, a proper use of artificial manures also requires some knowledge of scientific principles. But when this is present their application is certainly very profitable. The following table giving the result of certain experiments carried on with artificial manures on paddy fields, sufficiently illustrates what we have stated above:—

	Gross Value.	Net Profit.
Unmanured plots ...	Rs. 27	Rs. 10
Manured, manure worth Rs. 3-8	,, 48	,, 27
,, ,, ,, 6-0	,, 47	,, 21
,, ,, ,, 9-0	,, 62	,, 32
,, ,, ,, 16-0	,, 53	,, 15

It is clear that *suitable* manures, in *proper* quantities are very paying.

SUBSIDIARY INDUSTRIES.

One of the many directions in which improvements in the Indian Agricultural system are possible, the introduction of subsidiary industries, is by no means the least important. Among the industries which may easily be started as subsidiary industries the following claim particular attention, namely, :—Sericulture, agriculture, floriculture, cattle and poultry farming, and hand-loom weaving. Each of the above can be carried on as a principal industry, if conducted on a large scale, but as a subsidiary one for small farmers they are specially adapted. They do not require any exceptional skill, large capital, or sole devotion to the same industry throughout the year, and will furnish occupation to a large number of male, as well as female agriculturists, without in any way interfering with their ordinary occupations. In connection with this, specially the hand-loom industry, Mr. Mukerji, the Assistant Director

of Agriculture, Bengal, very correctly says that "there are millions of women, Hindu and Mahomedan, who are debarred by social etiquette, and the exigencies of domestic life, from working outside their own homes. Employment should be found for their idle hours. They are able to spin, as their grandmothers used to do not so very long ago when the "Churka" was a great feature of every home. There is no competition of wages here. There are hundreds of thousands of poor widows who would be too glad to add something however small to their present incomes. It is not necessary to grow cotton for this purpose, where other crops are grown at present. The cotton required may be imported from other parts of the country." One reason why the hand-loom industry is gradually dying out is, that good hand-looms are not available. A recently invented machine seems, however, to supply this want. Such improved machines, when available, should be placed before the village population, and attempts should be made to popularize them. Endeavours should

also be made to introduce improvements in the hand-loom so that a machine, simple, efficient, and cheap, may gradually be evolved.

Sericulture can be profitably started in many parts of India. It may consist in the cultivation of the (1) 'wild silks of India,' (2) in the culture of a worm that feeds on the castor-oil plant or the mango tree, and (3) in the culture of the Chinese or Japanese silkworm. The first depending only on certain wild jungle trees, is independent of all methods of culture. It also does not require, like the Chinese silk culture, the provision of an adventitious food in the form of mulberry leaves, and is therefore inexpensive. Secondly, the culture of the silkworm feeding on the castor plant is not known in this country; but in view of the fact that this plant is widely grown in India, this worm can be easily reared in any part of the country. These remarks also apply to *Circula Trinfenestrata*, or mango silkworm. The difficulty in connection with this worm is the irregular manner in which it lays the fibres of the cocoons, and the gum with which the silk

is loaded. This makes the reeling of the silk impossible at present. It can be used, however, in the manufacture of 'waste' or floss of a good quality, from which a very fine silk may be spun. It is probable that the invention of suitable machinery will make it possible to utilize fully the superior silk produced by this worm.

Thirdly, the silkworm proper can also be reared in many parts of India, where the mulberry tree can be grown. It is said to require a mild equable climate free from excess of heat or moisture. It has been successfully reared in the cold climate of Kashmir and in the comparatively hot climate of Burma. The mulberry tree, on which it likes to feed, grows on almost any soil and is easily propagated.

It appears from what we have stated above that if sufficient efforts are made, sericulture may one day become a very flourishing industry in India. At present it is often unsuccessful through want of attention to the following :—(1) The silkworm requires

protection from the ants and flies. (2) It requires regular feeding. (3) It should not be placed near tobacco. (4) The eggs should not hatch long before new leaves begin to appear on the tree. (5) Hibernation houses are essential, &c.

Apiculture or bee-farming, though a very suitable industry for the agricultural classes, is not carried on in many parts of the country. But in view of the growing demand for honey and wax it is not too much to say that this industry has a great future before it. Both honey and wax are in great demand and this industry is particularly suitable for an agricultural people like ours. At present this industry, as it is understood in Europe, is scarcely carried on anywhere in India, the produce being collected by hill-men from the natural haunts of the bees. The defects of this haphazard method are three, namely:—(1) Only a limited quantity of the pure article is available. (2) We have no control over the quality of the honey produced. (3) When the trouble and physical hardships involved

are considered, the industry cannot be regarded as paying.

It is the belief of some experts that the European bee (Apis Meliifica) can be more easily domesticated and trained than the Indian bee. This view, however, seems to be erroneous. There are several distinct varieties of the Indian bee and it is very likely that some of them can be trained so as to yield honey of a good quality in large quantities. At present four varieties of bees are particularly well known: (1) Apis Meleponi ; (2) Apis Dorsata ; (3) Apis Florea ; and (4) Apis India. The chief characteristics of the first two kinds is that they prefer to stick to one locality all the year round. If their comb is removed they build another somewhere near the place where the former one was placed. Apis Meliponi is also known as the Mosquito bee being of a small size. Apis Dorsata is comparatively a large bee, and being of a ferocious nature attacks any one trying to remove the comb. The third and fourth varieties are distinguished by their migratory habits. They

frequently change their habitat so as to take full advantage of their favourite food, namely, the blossoms of the plants of the Strobelanthes genus of Hancenthaceo.

The honey produced by these bees is of three kinds: The "Rock Honey"; this is made by the larger varieties and found among the hollows of rocks. It is of a dark colour and though found in comparatively large quantities, both the honey and the wax are of an inferior quality. Moreover, it is sometimes poisonous, on account of having been collected from the blossoms of *Sapium Indicum*, a very poisonous flower.

The honey produced by the middle-sized bee is of a lighter colour and medium quality. But the best honey is the product of the "Mosquito bee."

Attempts should therefore be made to domesticate this bee. The home-sticking habits of this bee will make it comparatively easy and its produce (both honey and wax) will fetch a good price in the market.

To be successful, Apiarists have to pay particular attention to the following points:

The bees should be trained so as to discriminate between injurious and harmless flowers. For instance, the honey derived from Strobilanthus and Misnaferea species of flowers is regarded as a good quality, whereas that collected from certain other flowers is sometimes positively injurious. Advantage should be taken of the best appliances, *e. g.*, frame-hives, smokers, queen-cages, etc. If crude methods only are employed the result will be of a poor quality, and disappointing. The wax also, if purified by melting and straining through a piece of cloth, will fetch a good price. Some people recommend the addition of a little turmeric to the wax by way of imparting a beautiful finish to it.

Floriculture also deserves much attention as a profitable industry. The single instance of rose-water and rose 'attar' (otto) shows that the industry can be carried on without the assistance of complicated machinery.

The cost of growing roses comes to about Rs. 50 to Rs. 70 per acre ; the outturn nearly 1,00,000 to 1,20,000 roses valued at Rs. 70

to Rs. 100 per lakh. The rose water is manufactured by distilling roses by a simple method, the price obtained being about Rs. 25 to Rs. 70 per 15 Quarts. The otto of the rose of a superior quality fetches from Rs. 80 to Rs. 250 per tola, even inferior pure 'attars' selling at Rs. 10 per tola.

Cattle and Poultry Farming is a subject full of importance to the agricultural classes. Even if we take 100 heads of cattle per square mile as a basis for calculation, the total number of cattle in India comes to about 17 crores. Besides this they form the ryot's capital. They supply him with milk and meat; they do the rural labour of the field; they produce the manure, in the form of farm-yard manure, which also supplies the farmer's fuel.

The improvement in cattle farming may chiefly take the following directions:—(1) Improvement in the breed of cattle; some useful work has already been accomplished in this direction in our Presidency, especially through the instrumentality of the Agricultural Department. An improved breed of cattle

will make the keeping of cattle more profitable by increasing the output of milk, and they will perform for the agriculturists, a greater amount of work. The present condition of the Indian cattle is, on the whole, poor, because of (1) Insufficiency of food. (2) Want of proper feeding. (3) Want of proper breeding. They are generally driven out to the pasturage and the banks of watercourses. They are also fed upon straw, and in some cases on rice-bran, oilcakes, tamarind seed, &c. The latter are, generally speaking, in a better condition than the former. The influence of food is proved by the fact that whereas ill-fed cattle do not weigh more than 700 to 800 lbs., well-fed cattle of the same breed weigh nearly 2,000 lbs. Besides this, it should be remembered that the best kinds of fodder are not necessarily dearer than others. The inferior fodders are often dearer simply because they are better known and widely used. Even in this single case there is ample scope for scientific improvement. It is also suggested that pastoral areas should be provided

and select bulls kept in the Agricultural Demonstration Farms, and breeding done there under scientific supervision.

The keeping of cattle and the dairy industry are of course interdependent upon each other. This industry is carried on in a very antiquated manner in many parts of India, whereby the output of milk and milk products is not satisfactory. Experiments carried out at Aligarh and Lucknow have shown the utility of employing improved European methods in the making of ghee and butter. The present method in vogue is as follows :—The milk is first boiled for the purpose of purifying it. Then some curd is added and the milk is allowed to stand at least 12 hours before churning it. Warm water is then added and when the butter begins to break, cold water is added. The butter is then gathered and boiled over the fire, until the water is evaporated and the curd deposited at the bottom of the vessel. According to this method from 16 to 18 lbs. of buffalo's milk and 26 lbs. of cow's milk is required to produce 1 lb. of butter of each.

According to the improved European method, the cream which the separator takes out of the milk, contains all the ghee, and the separated milk contains all that is required for drinking purposes and for use in making curds, cheeses, and sweetmeats. The cream being only a twelfth part of the whole reduces the labour and cost of fuel in making the ghee. Besides this, the outturn is large, 1 lb. of butter being produced from about 14 lbs. of buffalo's milk and less than 22 lbs. of cow's milk.

The demand for good dairy products is daily increasing. In large towns it is very difficult to obtain a supply of pure milk. It appears that ghee is being exported from the United Provinces to the extent of nearly 2½ lakhs of maunds, worth nearly a crore of rupees. This industry is now being placed in Gujrat, on a sounder basis, but the increasing price of milk and milk products shows that the demand is still greater than the supply.

Poultry raising is carried on in many parts of this country. But the perfunctory manner

in which it is conducted often makes the industry unprofitable. Another obstacle to its success is that eggs do not keep for a long time. Improved methods are likely to make the industry very profitable, as the demand for eggs is very large and increasing. If we can export eggs to European countries, there is no doubt that we can soon build up a large and lucrative trade. The United Kingdom imports eggs worth more than £4,000,000 annually. There is also a marked difference in price. The retail price of eggs in England is, we believe, two shillings a dozen whereas it is, from two to three shillings a gross here, while the cost price is much less. In this connection it is interesting to note the different methods adopted by other countries exporting eggs, so that they may be tested with a view to examine their suitability for this country.

Limewater-brine method :—This consists of mixing 16 ozs. of quicklime with 8 ozs. of common table salt. This is thoroughly slaked by adding one gallon of water. This water

is poured over the eggs until it covers them. The container is then placed in a cool cellar until the eggs are needed for use.

Water-glass method :—Soluble glass or silicate of lime is recognised now as the most reliable means of preserving eggs. The solution used for this purpose known as water-glass syrup can be obtained ready from large druggists. This is diluted in boiled water in the proportion of 1 quart of syrup to 9 quarts of water. When the solution is cool, it is ready for use. The eggs are placed, small end down, in some water-tight container, and then covered with the solution poured over them. The container should be made of galvanized iron, stoneware, glassware, etc., rather than wooden kegs, and such that can be covered. It should be placed in a cool room, well aired. Eggs may be kept in this manner from 6 to 12 months. When required the eggs should be washed or rinsed and dried in racks, when they will be ready for being shipped or used. In poultry-keeping one important thing to be kept in view is

economy in feeding. The revenue is not sufficient to allow reckless liberality in the provision of food, but at the same time the feeding should be such as not to interfere with their laying. In this connection experiments carried out by a European gentleman show interesting results. The two systems tried were the ordinary method of feeding with mixtures of soft food and grain and the "hopper" or American method. The latter, it may be stated, consists of the birds being automatically fed with dry meals ; the hopper is filled up at intervals of about a fortnight and no further attention is required ; hence there is a great saving in labour. But the cost of food comes to about Rs. 3-8-0 per bird, per annum, in the former case, whereas in the American system it is about Rs. 4. The latter system is also said to encourage rates, but where labour is an important item, it is of course preferable. Lastly, it may be added that a recent invention is likely to make the export of eggs possible in the form of a powder also. By a certain process it is alleged that eggs may be reduced to the form of a powder and kept for any length of time. By adding a little water to the powder what is practically beaten up eggs, are obtained.

A PLEA FOR IMPROVED AGRICULTURAL METHODS.

In the preceding chapters we have tried to indicate above a few directions in which the application of scientific improvements to the Indian Agricultural methods, will be accompanied by profitable results. Such application, however, requires certain conditions, which are rarely present in this country. The question therefore arises, in what way can we accomplish this desirable end? The chief difficulties in our way now are the following :—(1) Scarcity of capital. (2) Shyness or unenterprising character of Indian capital. (3) Want of skilled labour. (4) Absence of qualified foremen and overseers. (5) Ignorance and unfamiliarity of the capitalist classes, with the great potentialities of agriculture, etc. As regards the first, many qualified people are of opinion that a large amount of hoarded capital exists in the country. Lord Curzon is said to have put it at Rs. 44 crores ; others like Sir E. Cable put it

even at £300,000,000 ! Even assuming that a considerable amount of hoarded capital does not exist in the country, foreign capital should be welcomed. In these days of competition India cannot afford to refuse foreign capital simply on sentimental grounds. But at the same time attempts should be made to utilize in productive industries whatever surplus capital may exist in the country. A large amount of Indian capital (about 45 crores) is locked up in Government Paper and Savings Banks. A portion of this may well be employed in industries, through the medium of Banking Institutions.

During recent years several Indian Banks have been established in Bombay, Madras, and Lahore, and their successful working shows that Indians have a special aptitude for this line of business. It is necessary, however, that the whole country, be dotted with Banks, small or large, as the need may be, and they should be connected with the Central Banks in the Presidency towns. This will enable the Banks to make full use of their respective

capitals, as it often happens that one district or town is short of capital at a certain season, when another is in possession of a large amount of surplus money. Such a contingency is regular in occurrence and can easily be foreseen by expert Bankers, as it depends mainly on the principal crops or articles of trade in that centre. But the multiplication of Banking Institutions, and their establishment even in small towns, is perhaps a question of years. It cannot take place unless a 'habit of Banking' is developed among the people.

Another way in which the Agricultural classes could be assisted financially, is through the establishment of Co-operative Credit Societies. A beginning has already been made in this direction, and may well be persevered in. It is a well-known fact that the ryots are generally overburdened with debts. This takes away a large portion of their earnings. One reason why they are in debt is that the exorbitant interest charged by the local money-lenders soon multiplies the

original debt, small though it may be at first. These Agricultural Banks, or Co-operative Societies, even if they simply assist in removing the indebtedness of the agriculturists, will have justified their existence over and over again. But they have also another important work to perform. The potentialities of Indian agriculture cannot be turned into actualities without the assistance of capital. The ryot cannot introduce scientific improvements even if he knew how, and were also willing to do so, unless he could afford to undergo the initial cost. Here, the local Co-operative Credit Society could perform much useful work. It cannot be done by large Banks, from a distance. The amounts involved in each individual case would be too small for a Bank, and besides they cannot possess the requisite local knowledge. On the other hand, the Members of the Co-operative Credit Societies would know each other; this should enable them to give the loans more safely, as well as more usefully. Banking Institutions and individual Bankers should

therefore extend a sympathetic hand towards such Societies. They can do it without any risk of financial loss to themselves, as they can easily receive interest ranging from six to seven per cent. The Societies, on the other hand, by charging an interest higher than seven per cent., but much lower than that charged by individual money-lenders, can make arrangements also for the ultimate redemption of the debt.

Indian capitalists and educated classes are not only unenterprising as a rule, but are also somewhat prejudiced against agricultural industries. This fact is also very regrettable. Even the sons of farmers and shopkeepers, if they happen to receive some education, generally begin to entertain a sudden dislike for their parental occupation. Thus they drift to some office in some of the crowded cities and pass their life in clerical drudgery. The richer classes and the middle-classes also look down upon agricultural industries. The result is that the liberal professions are constantly becoming overcrowd-

ed. The two main causes of these are: (1) A disinclination towards any occupation involving manual labour, and secondly, the scanty profits of agricultural industries. As regards the first cause it may be hoped that the gradual spread of real education and true culture will remove it in time. But the second cause, though true enough at present, can best be removed by these very classes. Agricultural industries will soon become very paying, if suitable improvements are introduced into them. If any proof were required of this it is furnished by several agricultural industries carried on in an up-to-date manner by European planters.

Another great obstacle in our way is the almost total absence of skilled labour, competent foremen and able organisers. The example of Germany and Japan tend to show, however, that this difficulty is not insuperable. Hardly forty years ago Germany was an agricultural country; her export trade was insignificant. Now she is one of the leading industrial countries in the world. This

great success has been achieved in so short a time in two ways :—Through technical education, and (2) " by the copying of English methods of work, and the organisation of their industries, and by importing their machinery and by engaging their best men from their best shops ". The progress of Japan has also taken almost similar lines.

India fortunately possesses far greater resources than Japan, and in some respects she is better off than even Germany. The latter has now become a great manufacturing country but has at the same time lost most of her agricultural industries. If scientific improvements are introduced into India, she will be able to start new manufacturing industries without losing any appreciable portion of her agricultural output. In fact, it is quite possible to increase the agricultural produce, and at the same time introduce many manufacturing industries. This may be done by means of improvements in the antiquated methods of agriculture and by combining, in certain cases, the agricultural industry with

the corresponding manufacturing industry. For instance, sugar cane growing may be combined with sugar-making, cotton cultivation with the textile industry, and the growing of oilseeds with the making of oils. One special advantage of this method is that the profits of one will make up for any possible losses on the other, and that improvements will result in each. Thus a cotton factory may lead to the growing of superior cotton on the fields connected with it, or on the other hand, superior cotton growing on the fields will lead to the installation of high-class machinery in the factory, with a view to utilize the raw material.

Skilled labour and efficient foremen and overseers may be created gradually with the help of technical education, and training under competent men imported from other advanced countries. Fortunately labour is not really scarce in the country ; the want of sufficient workmen felt at industrial centres is due, not to scarcity of men, but to the fact that too many men are now locked up in the agricultu-

ral industry. Besides this the Indian workman, in spite of his ignorance and conservatism, is apt to learn easily new methods and systems. Railway Workshops furnish an example; native blacksmiths usually turn out a product crude and unfinished; but under the training of European foremen in the Railway and Government Workshops they are gradually beginning to turn out work of a far better quality. Hence technical education should be made a national work. Technical Colleges and Schools should be established and scattered all over the country. Besides this, technical education should not be regarded as something apart from ordinary education, but as an essential part of it. It is hardly necessary to add that primary education must form the groundwork of technical education. It should therefore be preceded, and perhaps partly accompanied by free primary education. The time is perhaps not ripe for compulsory primary education, but there is little doubt that the time has now arrived when a powerful impetus may well be given to primary education.

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